The Integrator

Volume 8, No. 1 Published by the GSFC Networks and Mission Services Project March 1999

A Message From the Associate Director of Networks and Mission Services Projects

We are heading into the second half of the fiscal year with a number of successes behind us and several events on the horizon.

The first half of this fiscal year has been outstanding. In the past few months, we have witnessed a succession of first-rate Shuttle missions. Submillimeter Wave Astronomy Satellite (SWAS), Mars Orbiter and Mars Lander, and Stardust were all successfully launched. In addition, we achieved a milestone in human spaceflight as assembly of the International Space Station was set in motion.

Other accomplishments are notable as well. Transition of the initial release of the NCC98 to the operational environment was successfully completed. For the second time in six months, engineers have revitalized the European Space Agency's orbiting solar observatory Solar and Heliospheric Observatory (SOHO) and, in doing so, set a space record. This is the first time a spacecraft equipped with gyroscopes has continued to work without them. The Earth Radiation Budget Satellite (ERBS) is functioning within normal parameters despite numerous onboard equipment failures. ERBS continues to collect valuable science data. Details about these events are included in this publication.

As we head into the second half of the fiscal year, there are a number of significant milestones on the horizon. Final preparations are under way for the Landsat, Quick Scatterometer (QuickSCAT), and Wide-Field Infrared Explorer (WIRE) launches. QuickSCAT is an excellent example of the diverse complement of services the Networks and Mission Services Project is able to provide its customers. The spacecraft was procured by the Rapid Spacecraft Development Office; the Orbital Launch Services Project managed the launch vehicle; and data delivery will be done using the EOS Polar Ground Network. This coupling of services is indicative of the customer-oriented direction in which we are headed with the proposed assimilation of the Rapid Spacecraft Development Office, Orbital Launch Services, TDRS Project, and the Integrated Financial Management Project into the Code 450 organization.

In addition to supporting customer missions, our organization has made major progress in ensuring Y2K compliance and in preparation for the upcoming Center-wide ISO audit and certification process. We have completed the official transition phase of the Consolidated Space Operations Contract (CSOC), and continue to work through the issues we encounter as we solidify NASA's new way of doing business.

Many challenges await us. I urge each of you to continue to look for ways to positively affect Goddard's role in the space community. I am proud of the sustained level of service our organization provides to our diverse customer community.

Phil Liebrecht

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Network Elements

Rave Reviews for Flight Dynamics Web Site

The recently revamped Flight Dynamics Product Center (FDPC) received rave reviews during demonstrations in January. The FDPC delivers flight dynamics products through the Internet to customers worldwide.

Many flight dynamics products are generated for current NASA-funded projects; the FDPC makes these products available to the general customer community for scientific use. Analysts in government, industry, and academia use the FDPC to download current spacecraft ephemerides, orbital elements, tracking data, and other products. For example, the Network Control Center gets the Space Shuttle ground trace via the FDPC.

Recent upgrades to the FDPC provide a simpler customer interface, increased support, more types of products, and faster response to special requests. Future plans include on-demand generation and delivery of flight dynamics products. GSFC's Flight Dynamics Services Organization is the driving force behind these innovations.

Flight dynamics products for dozens of spacecraft can be downloaded from the FDPC through an Internet browser or through anonymous file transfer protocol (FTP). New product requests are accommodated, and suggestions are welcome. Come visit the FDPC at *http://mmfd.gsfc.nasa.gov/* and see what we can do for you!

By Holly L. Offerman

For more information contact Holly L. Offerman by email at holly.offerman@gsfc.nasa.gov

The White Sands Complex Achieves Admirable Proficiency Rating

The White Sands Complex (WSC) has experienced a few months of quiet since the implementation of the Consolidated Space Operations Contract (CSOC) in October 1998. No major WSC initiatives have been originated since the last issue of *The Integrator*.

WSC is proud to report that WSC and the Guam Remote Ground Terminal (GRGT) achieved a Proficiency Rating of 99.999% for the month of October. This is the much sought six sigma level of performance which represents the theoretical maximum. The 99.999% level was achieved while the personnel were involved with the CSOC contract transition, TDRS H, I, J modifications to ground equipment, and the GRGT transition to full operations. Congratulations to all WSC and GRGT folks involved!.

WSC's ground system testing to support the next generation Tracking and Data Relay Satellite is proceeding as planned (see article on TDRS H, I, J on page 28). Tests are being executed smoothly and no problems are anticipated. WSC should be ready to support the new TDRS spacecraft on schedule.

By Douglas Perkins/ATSC/WSC Training

For more information, please see the WSC Project Office home page at http://wscproj.gsfc.nasa.gov or contact Jim Gavura, Station Director, or Bryan Gioannini, Deputy Station Director, at (505) 527-7000.

Science Data Processing Facility Supports New Mission

Science Data Processing personnel have begun operational support for a new mission. With the successful launch of the Submillimeter Wave Astronomy Satellite (SWAS) on December 5, Science Data Processing personnel began supporting SWAS using a Data Processing System (DPS). The DPS is a single-mission version of the multi-mission Pacor II Data Capture Facility. The DPS receives file transfers from ground stations at Wallops and Poker Flat and generates level-zero data

products for delivery to the Smithsonian Astrophysical Observatory Science Operations Center (SAOSOC) in Cambridge, MA. This DPS technology has previously been implemented for other missions and is currently used operationally to perform level-zero data processing for the Advanced Composition Explorer (ACE) and Transition Region and Coronal Explorer (TRACE) missions.

Although only in its second month of operations, the SWAS DPS has processed data which has already yielded some exciting science discoveries. SWAS has detected large amounts of water vapor coming from very cold gas in five star-forming clouds of gas in our galaxy. Since these clouds may ultimately collapse to form stars and planets, this water vapor provides clues to the origin of water in our own solar system, and perhaps also on the Earth.

Science Data Processing personnel are currently preparing to support our next new mission, the Wide-Field Infrared Explorer (WIRE), which is scheduled to be launched on February 26. WIRE will also be supported using a DPS.

By Brian Repp/ATSC

For further information, please contact the author at (301) 286-3699 or via email at Brian.D.Repp.1@gsfc.nasa.gov

Merritt Island and Ponce DeLeon Successfully Support Shuttle Missions in Reengineered Configuration

The Merritt Island (MILA) and Ponce DeLeon (PDL) tracking stations successfully supported the launch of STS-95 on October 29, and STS-88 on December 4, using the reengineered ground systems as the primary and first backup equipment strings. Orbital support was provided flawlessly throughout both missions. Range safety support was provided by the legacy Telemetry and Communications Data System (TCDS) equipment.

Following the conclusion of Shuttle mission support, AlliedSignal Technical Services Corporation (ATSC) project engineers returned to the site to complete installation and test of a redesigned best source select capability. Final subsystem software upgrades were also installed and tested in January and February. Upgraded Range Safety System software has been provided by the vendor and is undergoing extensive testing with the Range Operations Center at Cape Canaveral. The new system will be declared operationally acceptable following the successful support of two consecutive Shuttle launches and completion of the remaining work stations for subsystem control.

Operations Controllers at MILA conducted station operations from the Monitor and Control (MCS) workstations for the first time. Enhanced MCS software capabilities are currently being installed and tested. The added features will permit equipment set up remotely from the MCS consoles, thus reducing the amount of labor intensive premission configuration and checkout. The remote monitor capability will also be extended to the Mission Operation Support Area (MOSA) at GSFC and the Shuttle Mission Control Center at Johnson Space Center.

The cost reduction objectives of the MILA/Bermuda Reengineering project are being realized in the reductions that have been made in technical operations staff. The remaining challenge will be to complete the work station control interfaces so that reliable operations can be achieved with the reduction in staff.

At the present time, the old TCDS equipment and cabling are being removed. The original microwave communications link between MILA and PDL has been decommissioned and the equipment removed. It has been replaced with a multiplexed landline service between the two stations. This new T-1 service was used for both STS-88 and STS-95. The removal of obsolete equipment will be completed by March 31, coincident with the end of the MBR project. ATSC will continue to provide sustaining engineering under the Consolidated Space Operations Contract.

By Ben Gallup/BA&H

For more information on MBR, please contact Frank Stocklin/ GSFC Code 451 at (301) 286-6339, or via email at Frank.Stocklin@gsfc.nasa.gov

User Planning System Readies for Network Control Center 1998 Compatibility

The User Planning System (UPS) is busy developing Release 12 to support NCC 1998 flexible scheduling capabilities. Release 12 should be available to customers approximately one month after the NCC 1998 Full Support release becomes operational.

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A new version of Release 11 (R11B2V4) is also now available to customers running on the Hewlett Packard (HP) platform. This version resolves an issue discovered during a recent Engineering Interface test. It was discovered that the NCC 1998 baseline version does not allow operators to erase old schedule requests – an option available in the legacy NCC. Under legacy baseline operations, NCC operators would erase conflicting schedule requests and ask UPS customers to resubmit. Since NCC 1998 does not allow this function, UPS customers would have resubmitted schedule requests with duplicate message IDs, resulting in rejection of the request. R11B2V4 resolves this issue by creating a unique message ID for every message sent to the NCC, including resubmitted schedule requests.

On the Year 2000 (Y2K) front, several UPS sites are operational with the UPS Y2K release (now R11B2V4). This version was recertified for Y2K compliance. These UPS sites are also using the TCP/IP interface protocol available since R11B2V2 and required for Y2K certification. The Nascom gateway is not Y2K compliant, and there are no plans to make it so. Therefore, the UPS project will be discontinuing support for the Nascom gateway as soon as all customers have transitioned to the Y2K release.

Over the past 12 months various UPS customers have been replacing their legacy Digital Equipment Corporation (DEC) platforms with new, more powerful HP platforms. Below is the status of UPS customers who are implementing this transition:

- The Multi Satellite Operations Control Center, supporting missions UARS, RXTE, TRMM, ERBS, CGRO and EUVE, has been operational with an updated HP platform for the past two years.
- The Hubble Space Telescope program has been operational with an HP platform since November.
- Landsat-7 has been testing with an HP platform, and upon successful launch, will be operational with the HP.
- Space Shuttle Operations personnel have completed installation of new HPs and are preparing for NCC validation testing.

As stated in previous *Integrator* articles, the UPS R11B2V4 provides the capability to communicate with the NCC via direct TCP/IP. Support for the UPS Nascom Gateway will be terminated in the fall of 1999.

By Howard Michelsen /CSC

Further information regarding the UPS Project can be found on the WWW at http://isolde.gsfc.nasa.gov/ups/ or contact the author via email at hmichels@cscmail.csc.com

Network Control Center News

The Network Control Center (NCC) has several ongoing activities and significant accomplishments to report for this issue of *The Integrator*.

The most significant milestone the NCC has reached recently is the completion of the NCC 98 Operational Readiness Review (ORR) and the successful delivery of NCC 98. The ORR was conducted on January 26 and concluded with approval to press on for the NCC 98 delivery, which was accomplished without incident on February 12, 1999. Several coordination activities took place in preparation for delivery, some of which are ongoing. Procedures are being finalized; customers were notified of the changes; Operations Control Room (OCR) consoles and video displays are being reconfigured; personnel are being trained; and testing was completed. Currently, NCC personnel are working to ready the Auxiliary Network Control Center (ANCC) for operations. Testing and development of the NCC 98 Completion Release also continues. The Completion Release will include Flexible Scheduling and will be delivered prior to June 1999.

Since June 1998, the NCC supported 22 Expendable Launch Vehicle launches and three Space Shuttle missions. During

The Network Control Center
at Goddard Space Flight Center in Greenbelt, MD

and since the STS-88 mission in December 1998, the NCC Performance Analysts (PAs) have provided continuous support for the International Space Station/Early Communications System (ISS/ECOMM) project. ISS/ECOMM provides early S-band communications from the ISS/Unity module. (See article on ECOMM, page 23.)

The Multi-Conferencing Digital Switch (MDS-1) voice system from the recently decommissioned Bermuda ground station arrived at the NCC. This voice system will replace/upgrade the NCC's existing system and assist with Year 2000 (Y2K) compliance. This system is scheduled to be operational in the fall of this year.

Overview classes for the White Sands Complex TCP/IP Data Interface Service Capability (WDISC) are currently being conducted in the NCC. WDISC is being implemented to serve customers who require TCP/IP access to the White Sands Complex (WSC) for telemetry and command processing via the closed Internet Protocol Operational Network (see WDISC article on page 22 for more information). Once per day, NCC operators will read the Space Network schedule from the NCC Data System (NCCDS), filter to find events supported by WDISC, enter the appropriate events into the WDISC scheduler, and transmit the information to the Programmable Telemetry Processor Timer software within the WDISC at WSC.

Representatives from Wallops Flight Facility visited the NCC to provide training and software support for the Ground Network Scheduling System Replacement (GNSSR), which is slated to replace the existing Ground Network Scheduling System. The new system is scheduled to be operational prior to March 1, 1999.

In addition, the NCC provided the following support since the last issue of *The Integrator*:

The Earth Radiation Budget Satellite (ERBS) experienced two low battery voltage conditions which led to two Spacecraft Emergencies on January 15 and 16 (see article on page 17).

NCC personnel assisted the Rossi X-Ray Timing Explorer (RXTE) in the resolution of the spacecraft emergency that took place on October 17 from 0148 to 2140Z. The Performance Analyst, in coordination with personnel at WSC, discovered that the polarization and the minimum/maximum EIRP values were incorrect. The values were corrected, and nominal data was received.

NCC provided continuous support to the Engineering Test Satellite VII (ETS-VII) project during their Target/Chaser rendezvous exercise. NCC personnel supported problems that were encountered and the overall mission was a success. The Space Network supported a total of 190 scheduled events and provided 7898 minutes of S-band Single Access support.

By Joe Snyder/ATSC

For further information, please contact Bill Webb/GSFC Code 451 at (301) 286-3264 or visit http://ncc.gsfc.nasa.gov on the World Wide Web.

NCC 98 Initial Release Is Operational!

The transition of the NCC 98 Initial Release to operations culminates a 5-year NCC 98 development, test, and integration effort. The objectives of the effort included the replacement of the obsolete components of the Network Control Center Data System (NCCDS) with more easily maintainable subsystems, the ability to support TCP/IP in addition to 4800 bit blocks, and the capability for customers to request services on the TDRS H,I,J spacecraft. The Initial Release also offers customers with the opportunity to obtain TDRS Unscheduled Time (TUT) information using a web browser. In addition, the release makes the NCCDS Year 2000 (Y2K) compliant.

To prepare the release for operations, the system test team completed over 300 test items; and the Operational Evaluation Team (OET) ran over 35 engineering interface tests, completed over 20 operational scenarios, and successfully conducted a Y2K interface test. OET members also worked closely with NCC operators to prepare and train them for the new platforms and applications associated with the release. Additionally, the release underwent stringent penetration tests to ensure data integrity was maintained.

At the NCC 98 Initial Release Operational Readiness Review (ORR), the project received Board approval to move forward with transition on the scheduled date of February 12. To prepare for the transition, several dry runs were coordinated by the release leader, a practice that proved to be instrumental in developing an accurate schedule and checklist for transition day. A web site was also developed for the transition effort to ensure open communications and to delineate specific customer and element roles and responsibilities prior, during, and after transition. These tools, in addition to a strong development, test, and operations team, led to a successful transition from the legacy system to NCC 98.

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With the completion of the Initial Release effort, the project is now focusing on the NCC 98 Completion Release. In the summer of 1998, the NCC 98 project was split into two releases to ensure an agency mandated Y2K implementation date could be achieved. The delivery of the Initial Release in February achieved the implementation mandate. The completion release effort will deliver the final NCC 98 capability – flexible scheduling.

The flexible scheduling capability, which will allow customers to identify tolerances on service start time, service duration of Space Network (SN) resources, and flexibility of the resource used for the service, will be a vital tool over the next several years, assisting in scheduling SN resources as the SN customer community expands. This feature will improve both the forecast and active scheduling, and will reduce the manual effort required by both SN customers and NCC personnel to create and maintain a conflict-free schedule.

Code correction activities are completed on the Completion Release, and it has been delivered to the testing teams. Both system testing and Operational Evaluation Testing are on schedule to conclude in early May, with a delivery to operations scheduled for late May.

The delivery of the NCC 98 Completion Release to operations and sustaining engineering activities for the NCC will be performed under the Consolidated Space Operations Contract.

By Shelley Harper/BA&H

For additional information about NCC 98, please contact Roger Clason at (301) 286-7431.

Earth Observing System Backbone Network Prepares for Year 2000

The Earth Observing System (EOS) Backbone Network (EBNet) communications equipment at the Svalbard Ground Station (SGS) in Norway was moved from the trailer where it had been housed for many years to a new building in January. A Computer Sciences Corporation engineer, Shane Smith, traveled to Norway to assist with the checkout of the NASA Integrated Services Network (NISN) equipment in the new location. The Timeplex multiplexers and Cisco routers were brought back up without problems at the new location. While on site, Mr. Smith also installed upgraded Erasable Programmable Read-Only Memory (EPROMs) in the multiplexers and replaced routers that were not Year 2000 (Y2K) compliant.

To meet Y2K compliance requirements, Cisco routers at the Alaska Ground Station (AGS), which the vendor does not certify as Y2K compliant, are being eliminated from the Version 0 and EBNet networks. The noncompliant routers are being replaced with Y2K-compliant routers or the circuits connected to them are being reterminated on EBNet routers that are compliant.

Testing in preparation for the QuikSCAT launch, now scheduled for April 27,1999, is ongoing. The testing is taking place between the Mission Operations Center (MOC) in Boulder, CO and the EOS Polar Ground Network (EPGN) ground stations, which include the AGS, SGS, and Wallops Ground Station (WGS). Testing with the McMurdo Ground Station (MGS) is expected to resume in mid February after hardware and software at the site have been upgraded.

By James M. Cameron/GSFC Code 291

For additional information on EBNet, please contact the author at (301) 286-6287 or via email at james.m.cameron.1@gsfc.nasa.gov

NASA Communications Division Prepares for Secure Gateway Transition

The NASA Communications Division (Nascom) is continuing its efforts to ensure that the Mission Critical Network and the networking devices that support the network are upgraded and Year 2000 (Y2K) compliant.

In the coming months, IPNOC (IP Network Operation Center) representatives will be contacting projects, asking them to provide Nascom with a list of required rules for each project. These requirements will be implemented in the new Secure Gateway. This new system will obligate projects to

change the IP addresses which they now use for sending/receiving data through the Nascom firewall. Further information will be provided to projects as they are contacted by the IPNOC representatives. The new Nascom Secure Gateway is Y2K compliant. To expedite the transition to the new secure gateway, projects may begin generating their rule base list and be prepared to provide the IPNOC with this information when they are contacted.

Nascom is also asking all projects that make use of the Secure Gateway to contact Matthew Kirichok (see contact information below) and notify him of a primary and secondary (if any) security point of contact. The IPNOC will work with these contacts to coordinate the changes that will be required for each project when using the new Secure Gateway and to explain how the project will use the new system.

Another change within Nascom is the implementation of a new procedure to submit Secure Gateway requests. Each primary and secondary (if any) security point of contact will be given an individual user account on a secure web page. From this web page, the designated contacts will be able to submit and update Secure Gateway requests. To obtain such an account, submit your request to the distribution list: ionet-gw@listserv.gsfc.nasa.gov

By Matthew Kirichok/GSFC Code 291

For further information, visit the Nascom home page at http://skynet.gsfc.nasa.gov/IONET or contact the author at (301) 286-3435 or via email at matthew.kirichok@gsfc.nasa.gov

Nascom Internet Protocol Transition Complete!

Nascom's conversion of institutional network services from 4800 bit-block protocol to Internet Protocol (IP) is complete, after two years. Small Conversion Devices (SCDs) and Programmable Telemetry Processors (PTPs) are deployed at all required sites.

All customers have transitioned from the Message Switching System (MSS) to the closed IP Operational Network (IONet). In January, the MSS was decommissioned and physically disconnected from the Front End SCD, which provided network service over the IONet.

All conversion devices need to have their MSS routing table updated with destination code-specific multicast addresses. Until this is accomplished, the MSS data will be routed to the Front End SCD, where data will be readdressed to the destination-code specific addresses.

Conversion Device (CD) Management and the IP Network Operation Center (IPNOC) continue to diligently manage and monitor conversion devices and the IP network. In January, CD Management created new tables, which are transparent to the customer, for each of the conversion devices in the network.

All routers and SCDs in the closed IONet are Year 2000 (Y2K) compliant. PTP Version 4.05.03, which supports unblocked circuits or sites with space limitations, was tested and is presently "compliant as used." A new version of the PTP, 4.06, was intended to alleviate Y2K problems; however, it was not deployed due to operational deficiencies. The current plan is to replace all PTPs with SCD 5.0, since it has enhanced features and is Y2K compliant.

Work on two SCD software releases, 4.4 and 5.0, is still in progress. The deployment of SCD release 4.4 is near completion. It will be deployed to service the MSS and blocked Multiplexer/Demultiplexer (MDM) circuits. These systems are used at the White Sands Complex and Johnson Space Center to convert Space Network data to and from the IP infrastructure. SCD release 5.0 is still in its development stage. This release will provide an improved method for managing PTP hardware. This transformation requires no hardware modification and is intended to have minimum impact to the network or customers.

Nascom engineers continue to work with customers to ensure smooth operations on the IP Network. Monthly status reports, the status of individual sites, and other information about the transition is available on the IP Transition homepage listed below.

By Aisha Anwar/BA&H

To obtain further technical information and points of contact regarding the Nascom IP transition effort, refer to the IP Transition Homepage at http://skynet.gsfc.nasa.gov/transition/ip-main.html or contact IP Transition Manager, Scott Douglas, at (301) 286-9550.

The South Pole Connection

McMurdo TDRS Relay System

The McMurdo TDRS Relay System (MTRS), installed in 1995, is a relay system that complements the 10 meter McMurdo Ground Station (MGS) in McMurdo Station, Antarctica. MGS's unique polar position enables it to receive RADARSAT data every orbit. MGS uses the MTRS system to send the data to the White Sands Complex (WSC) via TDRS. Without this system, RADARSAT data would sit on tapes for six months during the polar stations' "no travel" winter operations. MTRS allows speedy delivery of the science data to Alaska for timely data processing.

The MTRS continues to function well, relaying data to WSC in New Mexico at 150 Mbps. A test program, to be implemented soon, will ensure that the system is Year 2000 (Y2K) compliant.

MTRS was recently used to relay video from the South Pole for use on a CBS broadcast television morning talk show. After the short informational segment was filmed at the South Pole, the video tape was flown 800 miles to McMurdo where it was relayed to the WSC and then sent to CBS. It was a first to see an "almost live" broadcast from the South Pole.

Bill Watson (on Iridium phone), Phil Liebrecht, and Don Shinners (ATSC/WSC) at the South pole.

South Pole TDRS Relay

The South Pole TDRS Relay (SPTR) is a relay system that provides TCP/IP connectivity to the South Pole via TDRS. SPTR was built on an extremely short schedule and installed in December 1997. Before the advent of SPTR, personnel at the South Pole were in desperate need of Internet connectivity – it is their only means of contact with the world for both personal and science needs.

Providing a 1Mbit/sec full-duplex TCP/IP link via TDRS and a 2Mbit/sec one-way file transfer link was a challenging first for Space Network personnel. Now that the SPTR project has proved a success, it is opening the door for other TCP/IP links (as opposed to telemetry links) for other Space Network customers.

Although the system experiences occasional glitches with the complex router circuits, scientists continue to control instruments and receive huge quantities of data (4 gigabytes per day) from experiments at the South Pole using SPTR. A short four hour window of visibility to the South Pole using TDRS F1, the oldest satellite in the TDRS constellation, enables the connection.

This system was also used to relay a broadcast from the South Pole for CBS (see MTRS at left), although this footage has not aired yet. Tapes of the South Pole segment that SPTR relayed were recorded at WSC and will be available for local viewing at a later date.

By Andre Fortin/GSFC Code 451 and Frank Stocklin/ GSFC Code 451

For further information on MTRS or SPTR, contact Frank Stocklin at (301) 286-6339.

Look for more information on these two exciting projects in future issues of The Integrator!

Network Customers

Automation Aids Rossi X-Ray Timing Explorer Flight Ops Team

December of 1998 marked the three year anniversary of the Rossi X-Ray Timing Explorer (RXTE) mission. Since mission inception, numerous events and changes have taken place with regard to the spacecraft and the team that operates it.

Shortly after launch, solar array performance was discovered to be slightly degraded due to cracks in the array cells. Although these cracks have not prevented the spacecraft from performing its required operations, the power subsystem is monitored very closely. To alleviate high temperatures from further damaging the arrays, they are offset from the sunline during normal operations. Therefore, it is very important for the Flight Operations Team (FOT) to respond quickly to conditions that move the arrays directly onto the sunline (i.e., a safehold).

Automation has enabled a reduction in the number of FOT members. Shortly after launch, the FOT numbered in the mid-teens; automation currently allows a staff of six to operate the spacecraft around the clock. The Automated Mission Operation System (AMOS) performs all routine activities for which a Command Controller and Spacecraft Analyst would be responsible. These FOT members can now complete other tasks such as mission planning, trending, etc. AMOS configures the ground system for supports (over 30 per day), loads spacecraft memory, monitors the downlink of engineering and science data, and recovers data missed during transmission. The automated system will also alert the FOT of anomalous ground and spacecraft conditions through its automated paging system.

In addition to the ground automation, planned modifications to spacecraft memory will also lessen the FOT's workload. In the near future, the spacecraft will be able to autonomously recover from unscheduled instrument safing sequences – a current responsibility of the Science Operations Facility's Experiment Controllers.

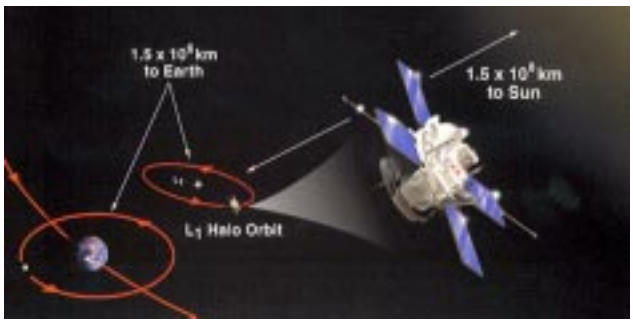
Given the present health of the spacecraft, on-board redundancy and the use of automation to curb the costs of spacecraft operations, the RXTE project hopes to continue to provide useful science data to the community well into the next century.

By Tim Coulter/ATSC

For more information, check out the following WWW site: http://heasarc.gsfc.nasa.gov/docs/xte/ or contact Robert Sodano/GSFC Code 581 at (301) 286-6506.

The Advanced Composition Explorer Completes Successful First Year On Orbit

The Advanced Composition Explorer (ACE) was launched on a Boeing Delta II 7920 rocket from Cape Canaveral on August 25, 1997, with nine instruments that measure the elemental, isotopic, and ionic charge state composition of energetic particles over a wide energy range and the interplanetary magnetic field. In order to avoid the effects of the Earth's magnetic field, ACE traveled to the L1 Earth-Sun libration point nearly a million miles sunward of the Earth. ACE was inserted into a halo orbit around the L1 point on December 11, 1997, and for more than a year has been successfully gathering data. ACE has a two-year minimum mission requirement and a five-year mission goal, but has enough fuel for attitude and orbit correction maneuvers for at least six more years.



ACE is located at the L1 libration point, 1.5 million kilometers sunward of the Earth. The L1 point is where the centripetal force and the gravitational pulls of the Earth and Sun balance.

ACE was the first mission of its size to use a "Common Ground Support System," in which the spacecraft integration and test (I&T) ground support, mission operations, and the ACE science center use a common system architecture and share core software, databases, and testing procedures. This has been very successful even though the I&T occurred at Johns Hopkins University Applied Physics Laboratory in

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Columbia, MD (the spacecraft contractor), mission operations is at GSFC, and the ACE science center is at the California Institute of Technology in Pasadena, CA (the Principal Investigator's institution).

The ACE Mission Operations Center at GSFC (*http://acefot1.gsfc.nasa.gov/ACE_MOC_HOME.html*) uses the Deep Space Network (DSN) to contact the ACE spacecraft once per day for 3-1/2 hours. During this period, the previous day's science data is dumped from the onboard solid-state recorders, and any needed commands for the instruments, maneuvers, etc., are sent. ACE is not a "pointed" spacecraft, the major requirement is that the top deck (with most of the instruments) point within 20 degrees of the sun and the high gain antenna on the bottom deck point within approximately 3 degrees of the Earth. Because of this flexibility, very little spacecraft commanding is required.

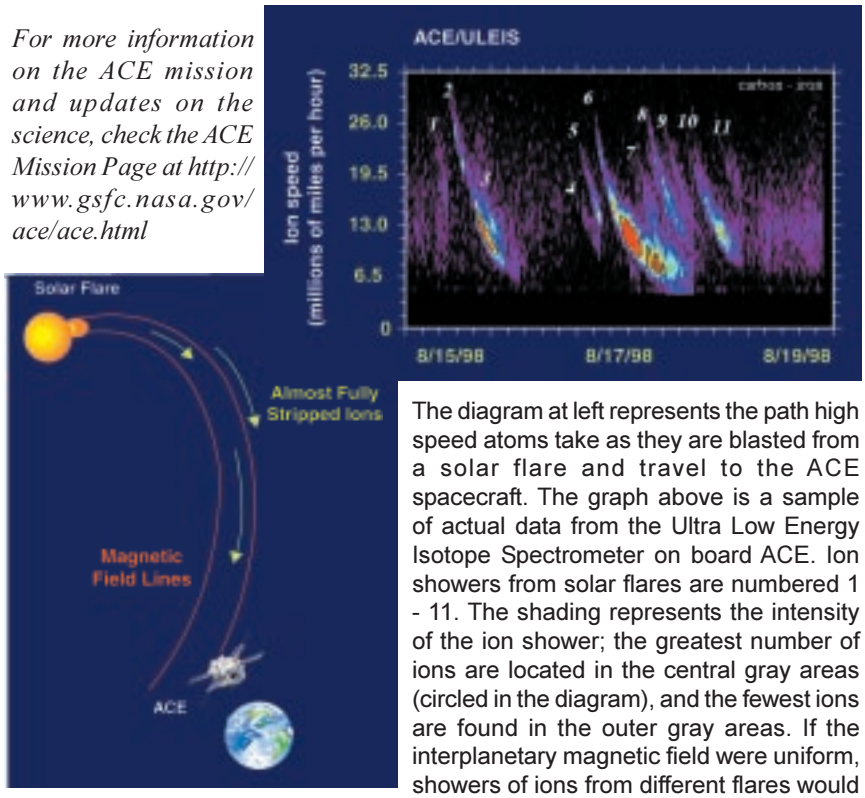
But even during the other 20 1/2 hours of each day, ACE is still communicating with Earth. The National Oceanic and Atmospheric Administration (NOAA) uses ACE real-time data to forecast geomagnetic storms. Severe magnetic storms cause communications problems, abruptly increase drag on spacecraft in low-earth orbit, can cause electric utility blackout over a wide area, and can be dangerous to astronauts. The location of ACE at L1 enables ACE to give about a one-hour advance warning of impending geomagnetic activity. NOAA has arranged for the transmission of a subset of data from four ACE instruments during the times when ACE is not transmitting its full telemetry to the DSN. The low data rate (464 bps) can be picked up by NOAA-operated ground stations, and, when combined with a real-time copy of the data stream from the DSN, give NOAA nearly 24-hour coverage for its forecast of impending "space weather." Within about 5 minutes, the data is available worldwide (see *http://sec.noaa.gov/ace/ACErtsw_home.html*).

The main scientific purpose of ACE is to compare and contrast the composition of the solar corona, the nearby interstellar medium, and the galaxy as a whole, and also to study how these particles obtained their high energies. Although data analysis is still ongoing, a lot of interesting information has already come from the high-resolution, large-area instruments on ACE. Results to date include evidence that there is a long (greater than 100,000 years) delay between when the material of galactic cosmic rays are synthesized and when they are accelerated up to nearly the speed of light (see *http://www.srl.caltech.edu/ACE/ACENews/ACENews17.html*), and the first measurements of the temperature of individual small solar impulsive events (see *ftp://pao.gsfc.nasa.gov/pub/pao/releases/1998/98-210.htm*).

A couple of times a month, science news from ACE is published on the worldwide web (*http://www.srl.caltech.edu/ACE/ACENews_curr.html*). We expect many more new and surprising results as the ACE mission continues.

By Eric R. Christian/GSFC Code 661, ACE Deputy Project Scientist, NASA Goddard Space Flight Center

For more information on the ACE mission and updates on the science, check the ACE Mission Page at http://www.gsfc.nasa.gov/ace/ace.html



The diagram at left represents the path high speed atoms take as they are blasted from a solar flare and travel to the ACE spacecraft. The graph above is a sample of actual data from the Ultra Low Energy Isotope Spectrometer on board ACE. Ion showers from solar flares are numbered 1 - 11. The shading represents the intensity of the ion shower; the greatest number of ions are located in the central gray areas (circled in the diagram), and the fewest ions are found in the outer gray areas. If the interplanetary magnetic field were uniform, showers of ions from different flares would all last about the same time, as the slower ions trail the fast ones. Occasionally, however, an ion shower from one flare suddenly 'turns off,' while the shower from a different flare continues unaffected (events # 5 & 6). Apparently, some unknown feature of the interplanetary magnetic field must have severed the magnetic pathway between one of the events and ACE without severing the other. ACE provides a tool for diagnosing the structure of this unseen field.

Extreme Ultraviolet Explorer Project Closes Out '98 and Prepares for '99

As 1998 ended and 1999 began, life at NASA's Extreme Ultraviolet Explorer (EUVE) Project at the University of California at Berkeley (UCB) continued to be busy. On the science side, the EUVE observatory conducted a number of interesting and challenging observations (including of the Leonid Meteor Storm!), and the Project carried out another successful announcement of opportunity for new proposals. Work was no less interesting and challenging on the operations end, as the Flight Operations Team (FOT) completed a battery reconditioning, additional operations automation, and preliminary Year 2000 activities.

During the past several months EUVE conducted over 120 separate pointings of nearly 30 guest observer targets. Among the most operationally interesting of these observations were the following. On October 6-11 EUVE observed the molecular cloud MBM 2, an undertaking requiring 25 individual pointings spread out somewhat randomly across the cloud in an effort to measure the diffuse EUV background. On December 9-10, EUVE observed the near interstellar medium neutral helium in the solar wind's "downwind" direction, requiring 15 individual pointings. This effort was coordinated with the SOHO and ACE spacecraft. EUVE also conducted a combined imaging/ spectroscopy study of the Moon at different phases, which required observing the moon every other day over the course of two weeks beginning on January 24. Moon observations were required approximately 8 orbits per day using both the spectrometer and imaging telescopes, which are mounted at 90 degrees to one another.

In November 1998, EUVE flew through the Leonid Meteor Storm without a scratch. Six hours prior to the storm's predicted peak on November 18, the FOT oriented the spacecraft to provide maximal protection for those components that would be most susceptible to impact, especially the high-gain antenna and solar arrays. The FOT planned to leave the spacecraft in this configuration, with all science instruments fully powered up and taking data, until six hours after the predicted peak. However, late on November 18 NASA informed missions that the peak may have been miscalculated, and so recommended that safe spacecraft configurations be extended for another 24-hour period. The EUVE Project complied with this recommendation, after which the FOT reoriented the spacecraft to resume normal science observations. After the storm NASA determined that the peak had probably actually occurred on November 17 – before any missions had taken safety precautions! In any event, the EUVE satellite showed no discernible effects from this "storm" and saw nothing of obvious interest in the recorded science data.

Although the Leonid Shower proved only to be interesting from an operations viewpoint, EUVE observations continued to yield new science results. One notable example was the discovery, by Drs. Burleigh and Barstow (University of Leicester, England), of a hot white dwarf companion to the hot B star Theta Hya. This, the second conclusive identification of such a B star-white dwarf binary system, is an important discovery because it allows scientists to place lower limits on the maximum mass for white dwarf progenitor stars, and to investigate the upper end of the initial-final mass relation for those stars. In another discovery Drs. Bowyer and Berghofer (University of California, Berkeley), in their study of EUVE observational data from the cluster of galaxies Abell 1795, have uncovered evidence that high-energy cosmic rays may be the source of the mysterious EUV emission in these clusters. More details on these and other EUVE discoveries are available on the official EUVE Project Web site at *http://www.cea.berkeley.edu*.

To ensure future discoveries, in late October 1998, the EUVE Project released to the astronomical community an Announcement of Opportunity (AO) for Cycle 7 EUVE Guest Observer (GO) observations, with proposals due in early December. In concert with the wishes of the 1998 Senior Review, the main scientific focus of "AO7" is on supporting the cross-calibration and coordination of observations between EUVE and the soon-to-be-launched Chandra (a.k.a., AXAF, Advanced X-ray Astrophysics Facility) observatory. The AO7 call encouraged proposers to request large observing programs with very long exposure times (> 900 ksec), which was a major change from previous AOs. The proposal process that was employed built on UCB's experience gained during its first managed AO, the highly successful AO6 process, and employed a streamlined electronic proposal submission and review system. The process was a great success with 50 proposals submitted, 39 approved, and an over-subscription rate of five times the available observing time – the highest demand in recent years! Observations for EUVE AO7 will be conducted from March 1999 to March 2000.

In addition to these science topics, the EUVE Project continued to attend to major issues in mission operations. In mid December 1998, the FOT reconditioned the spacecraft's three on-board Nickel-Cadmium batteries. This

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action was prompted by increasingly high battery differential voltage (dV) levels that began about a week earlier. Through consultation with battery experts at GSFC's Power Branch, the cause of the high dV levels was determined to be "gumming" of the battery electrodes via the formation of hydrogen bubbles within the battery. This "gumming" was probably a combined result of the current short orbital eclipse periods, which allow for only minimal battery discharge, and of a low solar array offset, which prompted high battery in-rush currents. Engineers determined that a reconditioning would be the best course of corrective action, and on December 15-16, the FOT implemented the process. The three batteries were allowed to discharge to ~75% state-of-charge over the course of four orbits, and then returned to full charge over the course of the subsequent two orbits. The reconditioning proceeded very smoothly and no problems were encountered. Within a day the battery dV levels had returned to nominal readings and have remained there since.

As reported in the previous issue of *The Integrator* (Vol. 7, No. 2, November 1998), the FOT now operates EUVE in an every-other-day real-time support scenario. In addition, the FOT recently began to routinely schedule all three daily tape recorder dumps to be conducted autonomously and to occur at spaced time intervals so as to minimize thermal effects on the recorders. Also, the FOT developed some simple software scripts to bridge the manual processing gap between the GSFC-developed data reception front-end system and the UCB-developed Packet Processor (Pacor) replacement data distribution system. This bridge serves to fully automate the entire data dumping, receiving, processing, and archiving cycle. As a result, the FOT needs to "staff" only 1-2 real-time passes every other day in order to load the small number of flight computer table updates required to maintain the spacecraft and payload systems. This automation work has allowed the FOT members to continue to cross-train in other areas and to concentrate on additional engineering tasks and other miscellaneous issues.

Last, but certainly not least, with EUVE operations now projected to last through FY00 UCB has begun working in earnest on the Year 2000 (Y2K) problem, which will be the mission's major focus project for 1999. UCB is developing a master inventory and status "punch list" of all relevant hardware and software systems and utilities. After prioritization by criticality, these items will be individually worked and tested for Y2K compliance. Some interface tests with GSFC (i.e., with the Network Control Center) have already begun, and initial work with GSFC on critical GSFC-developed systems (e.g., the spacecraft command and control system) has started. During 1999, UCB will also be willing to act as test-bed site, on a best-effort basis, in order to help support other missions in their Y2K efforts.

By Brett Stroozas/EUVE Project/ Mission Manager

For more information, visit the UCB/ EUVE WWW site at http:// www.cea.berkeley.edu or contact the author at (510) 643-7312 or via email at bretts@cea.berkeley.edu

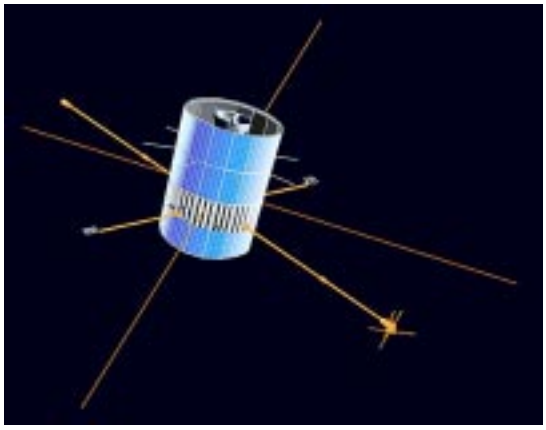
Interplanetary Monitoring Platform 8 Reaches Quarter of a Century Mark

NASA's Interplanetary Monitoring Platform 8 (IMP 8), the last in a series of ten IMP spacecraft, recently celebrated its 25th anniversary on orbit. The satellite, launched October 26, 1973, continues to provide scientists with useful data about the magnetic fields, plasmas, and energetic particles contained in the Earth's magnetotail and magnetosheath and the solar wind. IMP 8 measurements are carried out in situ; it does not perform remote sensing.

IMP 8 is in a near-circular, 12-day orbit, that is approximately 35 earth radii. Unlike most modern spacecraft, IMP 8 transmits data in the Very High Frequency (VHF) range. Most of the ground stations that once sent and received IMP 8 transmissions at the beginning of its lifetime became obsolete and have since been decommissioned. Since IMP 8 does not have the capability to record data, and must continually broadcast its data down to Earth, maintenance of a worldwide set of ground stations capable of capturing the satellite's data is vital to its mission.

The core ground station for IMP 8 functions at Wallops Flight Facility (WFF) in Wallops, VA. Arrangements with the European Space Agency (ESA) provide telemetry capture at an ESA station in Belgium. In addition, the IMP Project built another ground station in Canberra, Australia, which was completed eighteen months ago. These three ground stations furnish near-complete coverage for IMP 8 transmissions, allowing IMP 8 to extend its amazing useful lifetime.

For further information, please visit the IMP 8 web site at http://nssdc.gsfc.nasa.gov/space/imp-8.html or contact Dr. Joe King/Code 633 via email at King@nssdca.gsfc.nasa.gov.



Artist's Conception of the IMP 8 Satellite

Upper Atmosphere Research Satellite Achieves Milestones

Since publication of the last issue of *The Integrator*, the Upper Atmosphere Research Satellite (UARS) has achieved numerous milestones. UARS successfully survived its encounter with the Leonid meteor storm in November 1998, with no anomalies reported. After completion of planned testing, UARS transitioned to use of network IP protocol. In addition, UARS completed in-depth Year 2000 (Y2K) analysis and completed verification for Y2K compliance. Furthermore, the spacecraft passed a 40,000 orbit milestone on January 5, 1998.

UARS continues to collect science data from eight of the original ten instruments, utilizing time-shared operations to maximize science with available power. Three instruments – the Particle Environment Monitor (PEM), High Resolution Doppler Imager (HRDI), and Solar Stellar Irradiance Comparison Experiment (SOLSTICE) – are successfully utilizing "day only mode" operation. "Day only mode" implements autonomous on-board computer control to increase the utilization of solar array output during day periods. UARS data capture remains excellent at better than 99 percent.

UARS operated with a roll down of the cold side by 0.5 degrees from December 13, 1998 until January 11, 1999. This maneuver was implemented to support the Wind Imaging Interferometer (WINDII) instrument for Polar Mesospheric Cloud (PMC) observations in the southern hemisphere.

By John C. Speer/UARS Flight Operations Team

Comments or questions may be directed to Edward J. Macie, UARS Project Manager, Code 453.

Tropical Rainfall Measuring Mission Project Meets Challenges

In November of 1998, the Tropical Rainfall Measuring Mission (TRMM) satellite completed its first year of on-orbit operations. To date, over 99.9% of the available science data has been collected and processed for analysis by the TRMM science community. Over 7,500 TDRSS contacts have been performed since launch to recover science data and analyze the satellite's state of health. During the past few months the TRMM project has addressed numerous operational challenges.

A voltage converter in the Clouds and Earth's Radiant Energy System (CERES) science instrument experienced performance degradation. The output voltage of this 15V converter has reached values above 20V. The CERES science team from Langley Research Center decided late in 1998 to turn the instrument off while an investigation continues into the cause of this failure and the possibility of returning the instrument to an operational mode at some time in the future is considered. While the investigation continues, the instrument remains powered off except during a few specific high-priority science opportunities, when the CERES instrument is scheduled to do cooperative science with other satellites. Additional safeguards are put in place during these periods to ensure that further degradation of the anomalous voltage converter will not negatively impact the health of the spacecraft power system.

Since launch, the temperature of one of the TRMM solar array drive motors has been higher than predicted (only one drive motor has registered these higher temperatures because TRMM performs yaw maneuvers to keep the same sides of the spacecraft toward/away from the sun at all times). There are concerns that these higher temperatures may begin to have a negative effect on the drive motor lubricant and may reduce the ability of the motor to rotate the array to track the sun. In the near term, changes are being made to limit the range of motion of the solar arrays during nominal operations

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(from the current +/- 130 degrees to +/- 50 degrees from a feathered position). By limiting the array motion, the stress on the solar array drives will be reduced and the arrays will still be able to provide sufficient power to operate the satellite and to charge the batteries during the sunlit portion of each orbit. Longer term solutions are being analyzed to determine the optimal solution for limiting the stress on the array drive while still ensuring that the power requirements are met.

In early January 1999, the TRMM satellite transitioned automatically to a Sun Acquisition attitude control mode when an initial attempt to limit the solar array drive motion (to compensate for the high temperatures explained above) resulted in an on-board sensor mistakenly thinking that the solar arrays were not tracking the sun properly. A decision was made to return the spacecraft to a nominal operations mode with the original +/-130 degree solar array stops while investigation, analysis, and generation of an alternate proposal continues.

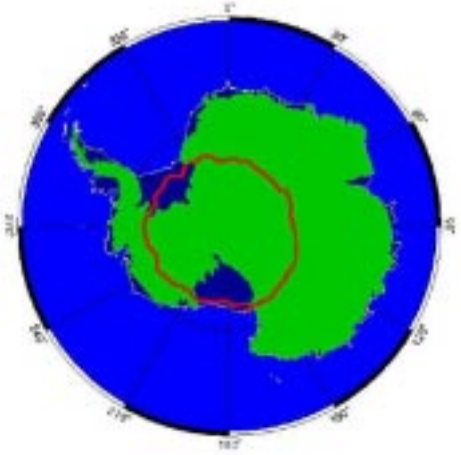
The TRMM Flight Operations Team (FOT) successfully developed and executed a risk reduction plan focused on powering off the TRMM science instruments during the predicted Leonid meteor storm peak. The FOT also performed increased state-of-health monitoring to ensure that any anomalies would be quickly identified. There were no anomalous conditions identified during the storm peak and the TRMM satellite was returned to nominal operations after the peak had passed.

By Jeff Volosin/ATSC/TRMM Flight Operations Manager

For more information, visit the TRMM web site at trmm.gsfc.nasa.gov or contact Ed Macie/GSFC Code 453 at (301) 286-0762.

Another Long Duration Balloon Program Mission Success

The Long Duration Balloon Program (LDBP) completed another circumglobal balloon flight launched from Williams Field, Antarctica this past January. This was the first LDB flight in Antarctica to fly a TDRSS transponder and was also the thirteenth "around the world" flight. Lucky Number 13 was launched on December 29, 1998, terminated on January 8, 1999, and recovered approximately 35 miles from the launch pad. Nominal altitudes during the flight were, as expected, between 115 Kft to 125 Kft.



The Global Positioning System Track of the Flight

The TDRSS support received from the networks personnel was once again excellent for the duration of the flight. Data was taken nearly the entire duration of the flight. Only a small portion (approximately 18 hours) was lost due to a scheduling problem at the LDB Payload Operations Control Center.

The scientific experiment flown included a mm-wave telescope. It was designed to measure tiny temperature fluctuations in the Cosmic Microwave Background (CMB), which is light from the early universe. The experiment worked flawlessly and much data was taken.

The LDBP expects to have two northern hemisphere flights from Fairbanks, Alaska in the May/June time frame.

By Bryan Stilwell/NSBF/Physical Sciences Laboratory, NMSU

For additional information, please contact the author at (903) 723-9097, or via email at Stilwell@master.nsbf.nasa.gov

Balloon Inflation Just Prior to Launch

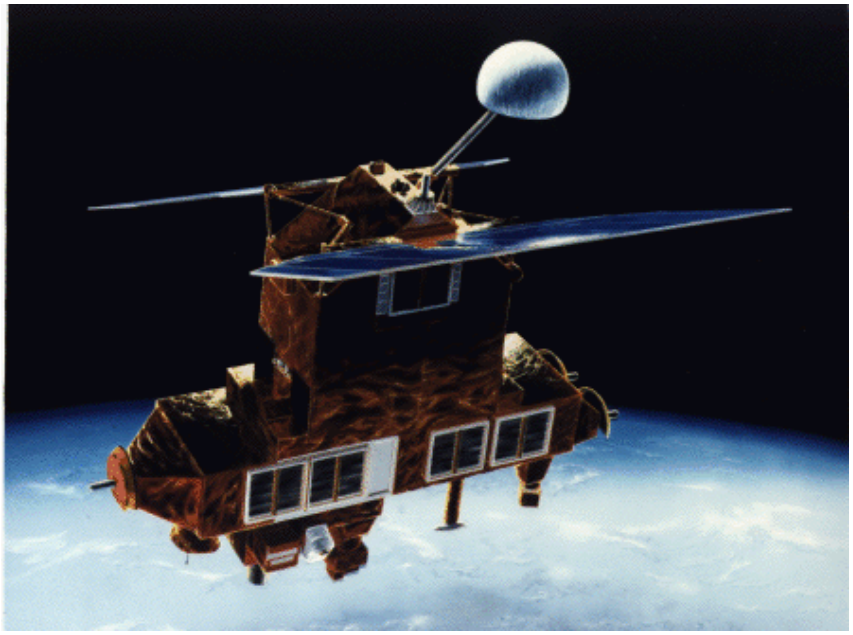
Earth Radiation Budget Satellite – The Mission Continues!

The Earth Radiation Budget Satellite (ERBS) has proved once again that it is a much tougher satellite than anyone thought. Despite numerous onboard equipment failures, ERBS continues its trek through Low Earth Orbit, collecting valuable science data.

Launched in October 1984 from the Space Shuttle Challenger, ERBS was destined to become a power engineer's nightmare and success story. Initially, ERBS was powered by two 22-cell 50 Amp-hour Ni/Cd batteries working in parallel. However, in August 1992, Battery #1 experienced a cell failure. A second cell failed in the same battery the following October. It was then decided to disconnect Battery #1 that same month and move to single battery operations.

Battery #2 provided sole power to ERBS without incident until June of 1993, when it experienced its first cell failure. A second cell failure occurred the next month. After this occurrence, both batteries had the same number of cells, so it was decided in August 1993 to reconnect Battery #1 and re-initiate parallel operations. Unfortunately, Battery #1 exhibited poor current sharing and was disconnected once again. Subsequently, Battery #2 was moved to manual charge management in the hopes of preventing further cell failures. At this point, it had only 20 working cells out of 22.

Five and a half years later, in November of 1998, Battery #2 experienced a drop in voltage equivalent to a single cell failure. On December 7, 1998, a single cell failed, and then on January 15, 1999, two more cells failed completely. This brought the total voltage down to that given by 16 cells. ERBS then entered a low voltage situation (19.97v) in which attitude control is severely degraded. Shortly after, the spacecraft went into B-dot mode (a controlled tumble following the Earth's magnetic field lines) due to a roll error spike of -23 degrees. Both science instruments, the Earth Radiation Budget Experiment Non-Scanner (ERBE-NS) and the Stratospheric Aerosols and Gases Experiment (SAGE-II), were taken off-line to reduce the power load.



Artist's Rendering of ERBS

After the minimum voltage increased, a command was sent to re-stabilize the ERBS trajectory. Seeing no way to continue reliable operations, it was decided to make a switch back to Battery #1 (with 20 cells) on January 25, 1999. The reconnection was a major effort and was successful due to the combined efforts of NASA, Ball Aerospace, and the ERBS Flight Operations Team. After evaluating the performance of Battery #1, Battery #2 was disconnected on January 27, 1999.

Currently, ERBS is in stable condition with the SAGE-II instrument functioning normally and providing good data. The ERBE-NS was brought back on line on February 5 after a successful yaw maneuver on February 3 and is functioning within normal parameters. With the current power situation, 99% of SAGE-II data and 100% of ERBE-NS data can be collected.

In conclusion, ERBS is now flying with the same power configuration as in August 1993. Scientists hope it will continue to provide good science data and overlap with the new SAGE-III instrument being launched aboard a Japanese research satellite this fall. Everyone involved is hoping ERBS has a successful 15th year of operations.

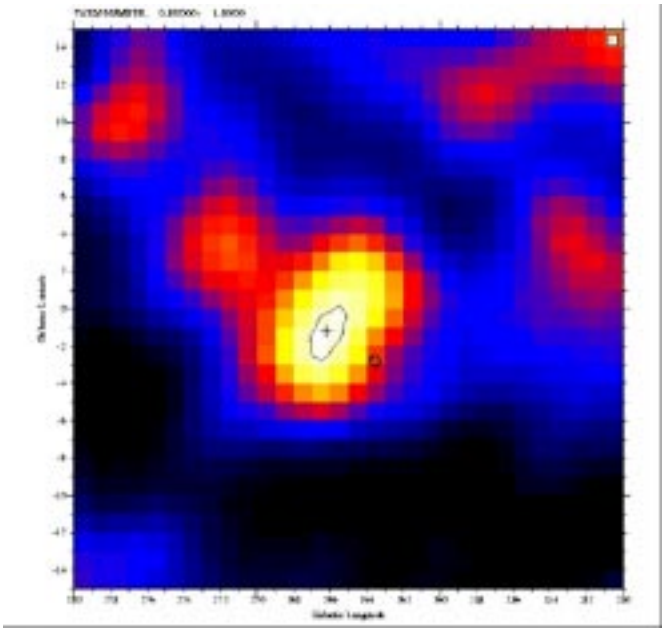
By Adam Beauregard/ATSC/ERBS Spacecraft Analyst

For more information, contact the ERBS Mission Director, Robert Sodano /NASA Code 581.1 at (301) 286-6506.

Compton Gamma Ray Observatory Continues Important Discoveries

The Compton Gamma Ray Observatory (CGRO) has nearly completed its eighth year of successful on-orbit operations, and current plans are to extend the mission through 2002, thus into the next millennium! The spacecraft and instrumentation have "aged" remarkably well – of the four experiment packages, only the Energetic Gamma-Ray Experiment Telescope (EGRET) has significantly degraded since launch (and this was anticipated, since it relies on a consumable detector gas supply). CGRO recently was configured into a "safe" attitude during the much anticipated Leonid Meteor shower (November 1998) – we are happy to report that it survived without incident!

More recently, new studies of the Earth's so called South Atlantic Anomaly (SAA) have been made with CGRO. The SAA is essentially a low-strength region in the Earth's magnetic field, which is geographically coincident with the southern-hemisphere portion of the Atlantic ocean. As CGRO, or any low-earth orbiting spacecraft, passes through it, the background noise due to charged particle interactions with detectors or other on-board electronic devices increases, in CGRO's case to intolerable levels. As we approach the 11-year maximum in the solar activity, which is associated with the well known increase in the number of "sunspots," the increased intensity in charged particle flux from the sun effectively expands the SAA. Scientists are estimating new SAA boundaries which will be used along with the predicted CGRO orbit to anticipate necessary modifications to CGRO flight-control parameters, thereby minimizing the impact on data quality.



An image constructed from a number of overlapping, off-axis COMPTEL exposures yielded the image shown here. The cross indicates the position of the SNR position and the contour indicates the uncertainty in the centroid of the3 1.16-MeV excess.

Preparation to avoid any problems associated with the much publicized "millennium bug" is continuing. In the fall of 1998, the CGRO Flight Operations Team, GSFC Flight Dynamics, the Instrument Teams, and the Science Support Center implemented an end-to-end test of the real-time data processing and archive "pipeline" systems. Test data, simulating the real operational data stream, were processed and transmitted through the actual flight data path – from raw telemetry packets, through the instrument specific processing software, to the final repository or "archive" at GSFC. Detailed analyses are ongoing, but thus far, no problems are anticipated.

On the science front, CGRO continues to uncover new and unexpected results. For example, there had been no supernova observed in the Galaxy for nearly 400 years, yet the observed spatial distribution of supernova remnants indicates that our record must be incomplete. The radioactive isotope ^{44}Ti is produced in different types of supernova, with mass yields ranging from one one-hundred thousandth to one-thousandth that of the sun. The decay of this isotope with a half-life of ~90 years is observable as a gamma-ray line feature at 1.16 MeV. Since the Galaxy is largely transparent to gamma rays, searches for 1.16-MeV line emission offer the possibility to detect heretofore unknown supernova remnants.

The plausibility of this approach has been demonstrated by the detection with CGRO's COMPton TELescope (COMPTEL) of a ^{44}Ti line emission coincident with Cassiopeia-A – the youngest known remnant. Using data from the German Roentgen Satellite (ROSAT) all-sky X-ray survey, scientists found an object exhibiting morphological and spectroscopic characteristics of a young Supernova Remnant (SNR G266.2-1.2) in a location slightly offset from the well known Vela Supernova Remnant (SNR). However, in lower energy X-ray emission, the newly found object is largely obscured by the Vela SNR. Fortunately, this region of sky has received extensive exposure with COMPTEL since the nearby Vela region has been the subject of intensive study. An image constructed from a number of overlapping COMPTEL exposures yielded the image shown here. The cross indicates the position of the SNR and the contour indicates the uncertainty in its positional determination.

From the gamma-ray line flux, the X-ray diameter and estimates of the ^{44}Ti yield, estimates of the distance to the newly found SNR and its age can be made. A distance of ~600 light years and an age of ~680 years are thus inferred. For larger Ti yields, the distance estimate increases, and the age decreases. At 200 parsecs, SNR G266.5-1.5 would be associated with the closest supernova event to the Earth in human history. Why then was it not recorded in the historical record? One can only speculate as to why it was not seen and noted. Perhaps it was optically subluminous for some reason, or perhaps it occurred at a particularly unfavorable time for observation.

The CGRO mission is currently budgeted to continue through the year 2002. Those of us affiliated with this mission are optimistic that it will continue to perform above our best expectations and that gamma-ray astronomy in the CGRO era will continue to flourish.

By Chris R. Shrader/Compton Gamma Ray Observatory Science Support Center, NASA GSFC

For additional information on CGRO, refer to "http://cossc.gsfc.nasa.gov" on the World Wide Web.

Solar and Heliospheric Observatory Operating Without Gyroscopes

WASHINGTON (AP) – A month after the gyroscope that kept it stable failed, the SOHO sun-observing satellite is back in business, keeping its balance by watching the stars.

It is the first time a spacecraft equipped with gyroscopes has carried on working without them, said Bernhard Fleck, European Space Agency project scientist for SOHO. "We are very pleased, very happy," he said.

He said the $1 billion satellite was returned to service Tuesday (Feb. 2), using a new computer program to help it keep its orientation without the failed gyroscope. SOHO stands for Solar and Heliospheric Observatory.

Trouble developed on SOHO last June when it began spinning out of control. Scientists were able to return it to service in September, but it was frozen, and two of its three gyroscopes failed, said Fleck, who is based at NASA's Goddard Space Flight Center in Greenbelt, MD.

The last gyroscope failed Dec. 21.Without the gyroscopes to keep track of its position, the satellite had to constantly fire onboard jets to keep it pointed toward the sun, a practice that threatened to rapidly exhaust its fuel supply.

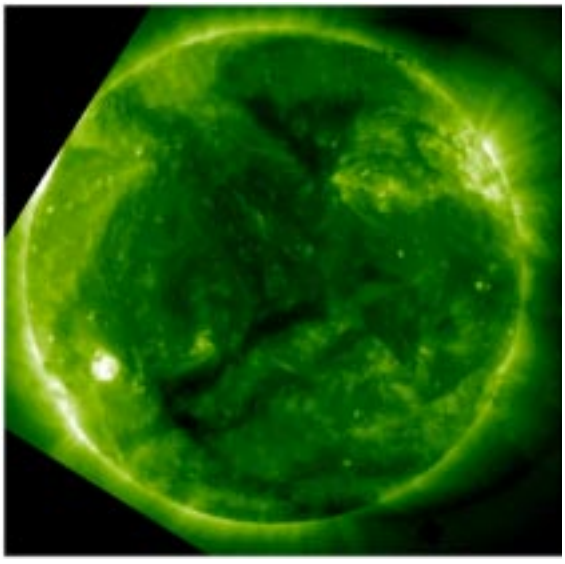
Fleck said engineers in the Netherlands were able to develop a computer program that allowed the satellite to bypass the broken gyroscopes and instead use a star tracker to allow it to determine its position.

With that information, three spinning momentum wheels aboard the craft can be directed to speed up or slow down to keep it properly oriented, he explained.

This was done on Saturday (Jan. 30), the craft was maneuvered to a new position on Monday and, on Tuesday, said Fleck, "we returned to normal where the spacecraft is perfectly pointing toward the sun."

SOHO was launched in December 1995, and the mission is now expected to continue until 2003, allowing it to observe intense solar activity when the number of sunspots reaches a maximum around mid 2000.

By The Associated Press



SOHO - First Gyroless Image
1999 February 2, 21:19 UT

TOPEX/Poseidon Currently Monitoring La Niña Condition in Pacific

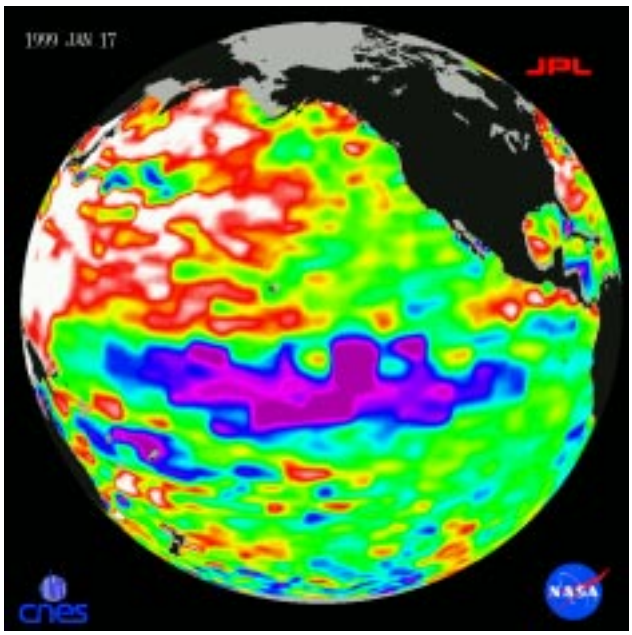
TOPEX/Poseidon continues to provide scientists with exciting and unique measurements of sea surface conditions as the Project celebrates 6-1/2 years of successful operations. Recent observations have confirmed the presence of a cold pool of water along the equator, commonly referred to as a "La Niña." A La Niña is basically the opposite of an El Niño condition and is associated with less moisture in the air over the ocean than in typical conditions. This type of event subsequently results in less rain along the west coasts of North and South America. According to oceanographers, the cold La Niña water acts like a boulder in a stream, steering the planet's prevailing winds and changing the course of storms that are born over the ocean.

Equally important to North America's winter weather is the very large area of an unusually warm Western Pacific Ocean that has also been observed by TOPEX/Poseidon. Although the appearance of this feature is not fully understood, it is currently adding a significant amount of energy to winter storms coming out of the North Pacific. This, in turn, is fueling a very volatile and unpredictable weather pattern over the entire continental U.S.

The satellite remains in excellent health, with all sensors continuing to be fully operational. Since our last report, we have experienced a slow but steady degradation in the overall performance of our primary sensor, the NASA Radar Altimeter (ALT). A decision will be made shortly whether to switch to the redundant ALT-B as the primary mission data source, subsequent to an engineering test of the B-side electronics.

By Mark Fujishin/Mission Manager, TOPEX/Poseidon Project

More information about the TOPEX/Poseidon spacecraft is available on the WWW at http://topex-www.jpl.nasa.gov/ or contact the author via email at Mark.Fujishin@jpl.nasa.gov



Indicates warm water

Indicates cold water

This image of the Pacific Ocean was produced using sea-surface height measurements taken by the U.S.-French TOPEX/Poseidon satellite. The image shows sea surface height relative to normal ocean conditions on January 17, 1999. Sea surface height is an indicator of the heat content of the ocean. This image also depicts the unusual large-scale warming in the northwest Pacific that was first observed by the satellite in November 1998.

Hubble Space Telescope Vision 2000 Control Center Is Operational

These last six months have been very busy for Hubble Space Telescope (HST) Project personnel and the infrastructure teams that support them! The HST Project has made many advances in two significant arenas – operations and science.

Deployment of the new HST Vision 2000 Control Center System is under way and is now in the transition phase. The Project has implemented an intensive delivery, testing and validation program over the last few months. During the month of January, both a Test Readiness Review (TRR) and an Operations Readiness Review (ORR) were presented and accepted. This effort culminated in the transition of spacecraft operations to the new system in late February. Testing and

operations personnel worked closely with the Space Network, validating all the new ground system components and procedures to ensure correct operation of the observatory.

The operational transition of the Vision 2000 Control Center System not only impacts Hubble, but also the telephone industry. Computer software developed for NASA's HST will soon help operate a worldwide, satellite-based phone system called Globalstar. This Hubble spin-off will provide Globalstar, LP, of San Jose, CA, with the technology to aid in delivering voice, data, fax and other telecommunications services to customers worldwide. The spin-off technology will satisfy the critical need for Globalstar engineers to remotely access spacecraft telemetry data from anywhere in the world. From multiple locations, Globalstar team members and partners will be able to coordinate efforts, and dynamically monitor and troubleshoot situations for the Globalstar constellation of 48 low-Earth orbiting satellites.

In addition, Hubble completed its complement of Year 2000 (Y2K) testing. Over the past several months, tests were coordinated with the individual systems that make up the Hubble system. Dry runs and "run for the record" runs in an end-to-end configuration were successfully completed. After the individual tests were finished, the authorizing monitor signed compliance.

HST also reached a significant science milestone in the last several months. Turning its penetrating vision toward southern skies, NASA's HST peered down a 12 billion light year long corridor loaded with a dazzling assortment of thousands of never-before-seen galaxies. The observation, called the Hubble Deep Field South (HDF-S), doubles the number of far-flung galaxies available to astronomers for use in deciphering the history of the universe. The 10-day-long observation was carried out in October 1998 by a team of astronomers at the Space Telescope Science Institute (STScI) in Baltimore, MD, and NASA's GSFC. "The southern field promises to be the most studied area of the sky over the next five years," says STScI astronomer Robert Williams. "We have eagerly awaited this new set of images ever since the first HDF, which had a dramatic impact on the entire science of astronomy. Hubble's deep field views revealed a large, heretofore unseen fraction of the universe and opened it up to interpretation and understanding."

During another observing period, Hubble was both observing a target and a target, itself. An anticipated celestial bombardment called the Leonid meteor storm in November did not deter NASA's Hubble Space Telescope from its key mission of gazing far across the universe – as long as the view was in the opposite direction of the incoming meteor swarm. A meteor storm is an expected downpour of thousands of meteors zooming by Earth. They posed a small but potential threat to Hubble and other satellites (see article on the Leonid storm in the November 1998 issue of *The Integrator*).

For a 10-hour period at the peak of the storm on November 17, the telescope was oriented with its aft bulkhead facing into the direction of the meteoroid stream. Hubble's solar panels were laying flat, or parallel to the meteoroid flow. Though most Leonid meteoroids are smaller than a grain of sand, they zoom across space at a menacing 155,000 miles per hour. A speck-sized meteoroid can pack the wallop of a .22 caliber bullet as it pierces a spacecraft hull. Still, even at the peak of meteor activity, the density of particles in any given region of space is extremely low.

Even so, the Space Telescope was not idle during the shower. Hubble was aimed at a quasar, the bright core of an active galaxy, approximately 10 billion light years away. Hubble wasn't studying the quasar itself but the surrounding galaxies, protogalaxies and primordial hydrogen clouds between us and the quasar. The quasar is so brilliant, it is like a searchlight shining through fog.

The Hubble Space Telescope Operations Management Support (HSTOMS) Office has a new manager. Since July 1998, Nathaniel (Nate) Wright has served as the HSTOMS Manager. Originally from Joliet, Illinois, Nate earned his degree in electrical engineering from Southern Illinois University in Carbondale. He went on to pursue graduate work at the University of Central Florida in Orlando, where he also spent over twelve years working at NASA's Kennedy Space Center.

By Art Hughes/GSFC Code 583

For additional information on HST activities, visit http://marvel.stsci.edu/top.html on the World Wide Web, or contact the author at (301) 286-7311 or via email at Arthur.R.Hughes.1@gsfc.nasa.gov

Additional Activities of Note

Space Network TCP/IP Services Available

The White Sands Complex (WSC) TCP/IP Data Interface Service Capability (WDISC) was recently installed at WSC and its Operational Readiness Review held on February 22, 1999. WDISC allows Space Network (SN) customers to receive telemetry and send commands using TCP/IP via the closed IP Operational Network (IONet).

WDISC was implemented in response to increasing requests from new customers for direct TCP/IP communications (versus UDP/IP encapsulated 4800 bit blocks) with the ground terminals at White Sands. Use of TCP/IP is anticipated to decrease costs associated with data transport services.

The initial WDISC customer set includes Far Ultraviolet Spectroscopy Explorer (FUSE), the New Millennium Program/Earth Orbiter-1 (NMP/EO-1), Gravity Probe B (GP-B) and the Microwave Anisotropy Probe (MAP). After a careful analysis of customer needs and WSC capabilities and constraints, a Project Plan and a set of requirements were generated. The SN project then procured the appropriate Programmable Telemetry Processors (PTPs) now installed at WSC. Engineers configured and tested the PTPs at GSFC, using mission test data and testing with customers when possible. After successful testing at GSFC, the equipment was shipped to WSC, where it was installed and the acceptance testing program was executed.

WDISC features are consistent with Consultative Committee for Space Data Systems (CCSDS) standards, including frame synchronization, randomization/derandomization, and Reed Solomon (RS) encoding. WDISC is anticipated to be able to accommodate future enhancements and modifications to allow the Space Network to support an increasingly diverse set of TCP/IP customers.

For more information on WDISC, please contact Reine Chimiak at (301) 286-3469, or via email at Reine.Chimak@gsfc.nasa.gov. Website http://nmsp.gsfc.nasa.gov/WDISC/index.html

Operating Missions as Nodes on the Internet: The OMNI Project

A cooperative effort is under way between GSFC Codes 451, 581, and 588 to demonstrate use of the Internet Protocol (IP) to provide end-to-end communication support for science missions such as satellites and balloons. The Operating Missions as Nodes on the Internet (OMNI) group is currently building an IP-based prototype system with components similar to those used in actual missions. The system consists of a "satellite" with an IP LAN, TDRSS communication link, Unix web server ground system, and customer interfaces on desktop computers employing web browsers and JAVA.

The satellite communication system consists of an Ethernet LAN, router, TDRS Early Communication (ECOMM) transceiver, automatic pointing antenna pedestal, and 12" antenna. The onboard processor is a PPC 603 processor running the VxWorks real-time operating system. This configuration is similar to the RAD 6000 processor and operating system currently used on many satellites. The science instruments consist of images from a video web server with multiple cameras, a weather station, and a Global Positioning System receiver.

Standard IP networking is used from the "satellite," through TDRSS to the White Sands Complex, across the Internet to GSFC, and from the OMNI control center to customers' desktops. The first goal of the prototype is to demonstrate end-to-end communication with the "satellite" while

OMNI development team: front row left-to-right: Tracy Dorsey, Ed Criscuolo, Francis Hallahan, Thinh Le; back row: Keith Hogie (Photograph by MJ Sherrod)

OMNI "Voyager" Satellite Ready for a Flight around GSFC

it is in a van driving around GSFC. Live data will flow from the satellite to customers' desktops via TDRSS.

The demonstrations of end-to-end IP communication began in February 1999. If you see a van with a weather station on the back, and a white antenna dome on top driving around GSFC, it is probably the OMNI van doing another demo. There is an OMNI web site for project information and live data access at *http://ssp.nascom.nasa.gov/omni/*

By Keith Hogie/CSC

For further information, please visit the web site referenced above, or contact Gary Meyers/GSFC Code 581 at (301) 286-5840.

Year 2000 End-to-End Test Planning Update

Since the last issue of *The Integrator*, all Network and Mission Services systems have completed the validation phase of Year 2000 (Y2K) End-to-End Test planning, and most have completed the implementation phase. The end-to-end testing process has progressed.

Several of the Rossi X-Ray Timing Explorer (RXTE) test cases have been successfully completed. Tapes with Y2K "test" data were provided to RXTE principal investigators who will ensure the data is acceptable.

The Test Plan for the Ground Network testing will be completed shortly; the emphasis will be on Mission to Planet Earth customers and exercising each different type of antenna system

A customer outreach presentation has been developed describing the end-to-end testing planned for the networks. The presentation can be accessed at: *http://www530.gsfc.nasa.gov/news/news.html*. We will be contacting all networks customers to go over the presentation and to discuss their Y2K test plans and status very soon.

A meeting was held recently to begin planning for the network support for the Human Exploration and Development System (HEDS) end-to-end testing that is being conducted by the Johnson Space Center (JSC). Space Network and Ground Networks support will be required for at least two of the four planned HEDS scenarios. At the meeting, several action items were assigned and will be worked over the next few weeks. One HEDS test will involve a Shuttle on the launch pad and will require significant coordination between the launch facilities at the Kennedy Space Center, the Mission Control Center at JSC, and the networks providing the communications support. It should be an interesting and exciting test.

By Lynn Myers/GSFC Code 451.5

For further information regarding the Y2K effort, please contact the author at (301) 286-6343 or via email at Lynn.Myers@gsfc.nasa.gov

"Houston, ECOMM Is Working Perfectly!"

The STS-88 mission, which began December 4, 1998, marked a historical milestone for NASA, the International Space Station (ISS) program, and the international space community. STS-88 delivered the first U.S. component of the ISS (Node 1 Unity module), docked, and attached it to the Russian built Zarya Functional Cargo Block (FGB).

As noted in previous *Integrator* articles, the Networks and Mission Service Projects (N&MSP) plays an essential role in NASA Human Spaceflight activities, but perhaps none as exciting as that provided to STS-88. This mission was anxiously anticipated by GSFC Networks personnel, not only because the TDRSS was providing communications for the first U.S. ISS mission, but also because the GSFC ISS/Early Communications (ECOMM) Test Team was bringing the GSFC ECOMM Transceiver to on-orbit operations with total mission success!

After two years of design, development, and test activities, team spirit soared as final steps to ECOMM System activation came to fruition on December 10, 1998. From the GSFC Network Control Center (NCC) and the Stanford Telecommunication (the transceiver manufacturer) facility in Reston, VA, team members anxiously watched while the astronauts performed installation and checkout procedures in the ISS Node 1. ECOMM installation was completed and successfully activated at 9:09pm (Eastern Time). The low data rate (LDR - 20.48 kbps) telemetry acquired immediately and all data was perfect! The high data rate (HDR - 128 kbps) was also activated and commanded around 9:45pm.

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The final checkout of ECOMM on-orbit performance, HDR video conference, was set to begin with Mission Control Center-Houston (MCC-H), but was delayed due to a pre-scheduled Public Affairs Office (PAO) crew interview. The GSFC Team waited patiently while the crew wrapped up the interview. At 10:30 p.m., the video conferencing capability checkout began; live ECOMM video flowed and was sent directly to NASA Select TV for all to see! A harrowing moment quickly turned to elation as the video images on the split screens (ISS crew and MCC-H) arrived clear and synchronized. The entire ECOMM team at GSFC, STel, and MCC-H were ecstatic and proud that the system worked so well and that they provided essentially the first audio and video from the new station.

Since activation, the Space Network has successfully supported ECOMM with S-Band Single Access (SA) and Multiple Access (MA) passes. An interesting item to note is that the ECOMM system was designed for SA and not initially intended for MA services; however, due to MA availability and ECOMM system extendibility, MA services are now provided for ongoing ECOMM operations.

Congratulations to the entire ECOMM Team! A special commendation goes to the GSFC ISS/ECOMM Team. There were many hurdles along the path – tight schedules, numerous flight design modifications, late night/early morning transceiver equipment re-engineering and environmental testing, just to mention a few. Without your dedication, sense of team, and "Can Do/Will Do" positive attitude, we could not have achieved success.

By Doug Lumsden and John Smith /LMSC/GSFC Code 451

Astronauts Newman and Ross Install ECOMM System into ISS Unity (Node 1)

For further information, check out the Human Spaceflight Web site at http:/shuttle.nasa.gov or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

TDRSS On-line Information Center

Have questions about TDRS or the Space Network? Check out the *TDRSS On-line Information Center*. New information about Demand Access, use of TDRS for Range Safety Support, and updated links to SN customer sites are just some of the latest improvements. Our Javascript search engine will help you locate the specific information you are looking for. You can also email us your questions using our feedback form. We'll direct your question to the appropriate expert and return an answer directly to you via email. Our link budget and User Spacecraft Clock Calibration System (USCCS) calculators have been improved and are available for your use. The site is updated twice monthly to ensure information is current and accurate.

The web site can be found at *http://nmsp.gsfc.nasa.gov/tdrss/*

Detailed information is currently available on:

- The Tracking and Data Relay Satellites (including TDRS H, I, J)
- The White Sands Complex
- Guam Remote Ground Terminal
- McMurdo TDRSS Relay Terminal System
- TDRSS Telecommunication Services
- Customer Communication Systems and Products (including Transponders)
- Current State of Ongoing Projects.

Plus much more…..

Coming Attractions

First International Space Station Multi-Element Integration Test Completed

Recall from previous *Integrator* articles that the Multi-Element Integration Test (MEIT) is a major ground assembly and integration test program for Flight Packages 3A (scheduled for launch in December 1999), 4A (February 2000), 5A (April 2000), 5A.1 (May 2000), and 6A (June 2000).

The primary objectives of this test program are to evaluate S-/Ku-Band flight model equipment functional interfaces with other on-board subsystems and the Tracking and Data Relay Satellite System (TDRSS), to validate/verify system requirements for end-to-end performance of S-/Ku-band on-orbit configurations, and to activate ISS power via commands from Houston Mission Control through the Space Network [White Sands Complex (WSC)/Tracking and Data Relay Satellite (TDRS).]

MEIT will be conducted in four test configurations (TC) replicating the on-board build sequence:

- MEIT TC #1 – S-Band Low Data Rate (12/6 kbps) to/from Mission Control Center-Houston (MCC-H) - Hardline and TDRSS RF
- MEIT TC #2 – Ku-Band Forward Link Space-Ground Tracking Receiver Controller (SGTRC) and Z1 Cable Downconversion
- MEIT TC #3 – S-Band High Data Rate (192/72 kbps) to/from MCC-H - Hardline & TDRSS RF
  - Audio to MCC-H Voice Checks - Hardline
  - UHF/ISS to Orbiter S-Band to MCC-H - Hardline
  - S-Band Forward to Setup Ku-Band - Hardline
  - S-Band and Ku-Band Payload Data Flows - TDRSS RF
- MEIT TC #4 – Space Station Remote Manipulator System (SSRMS) Video Tests

Goddard Space Flight Center (GSFC) Networks and Mission Services Projects (N&MSP) personnel will support each configuration. The test activities are led by the Kennedy Space Center (KSC) ISS Payload Test Team; however, with MEIT in full swing, the GSFC ISS Test Team continues to assist in providing Network components and establishing Network configurations to support the objectives of the testing.

MEIT Test Configuration #1 commenced on December 14, 1998 and was successfully completed on January 30, 1999. NASA Integrated Systems Network (NISN) and Merritt Island (MILA) Relay resources provided continuous support of 128 kbps Orbiter Interface Unit (OIU) data from the Space Station Processing Facility (SSPF) to Houston Mission Control throughout the entire test period. With the GFSC TDRSS User RF Test Set (TURFTS) in the hardline configuration (providing Baseband - RF conversion), testing of the 12 kbps ISS S-Band Return Link from the SSPF to Houston Mission Control was successfully completed.

MEIT TC #2 is due to begin on March 29 and conclude on April 13, 1999, and MEIT TC #3 is scheduled for April 20 - 28, 1999. In preparation for these phases of testing, GSFC has conducted Network testing to verify the Network elements (MILA Relay System) can receive and relay ISS Ku-Band 3 Mbps Forward Link data prior to the actual need date. Tests were successfully conducted at GSFC between WSC and the GSFC Compatibility Test Van (CTV). During that testing, equipment was identified that would assist in

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verifying the MILA Relay System's capability to relay the data from TDRS to the SSPF rooftop antenna, and then into the SSPF test area.

At the time of this writing, the CTV equipment and GSFC CTV personnel were at MILA Relay and SSPF confirming the following: that MILA Relay could receive the Ku-Band 3 Mbps Forward Link data; that MILA Relay could forward the Ku-Band 3 Mbps Forward Link data to the SSPF and into the test area; and verifying the true end-to-end configuration, with Houston Communications Control initiating the Ku-Band 3 Mbps Forward Link data and SSPF receiving the data.

In addition, MEIT management has requested that the GSFC CTV support the TC #2/3 ISS Ku-Band 75 Mbps return link data flows during the test period. For local testing, the CTV will be configured to simulate the Network. The Return Link RF signal will flow to the GSFC CTV, which will demodulate the data and send it back into the SSPF. For End-to-End (ETE) testing, immediately after the local testing, the RF will be routed through the GSFC CTV to TDRSS, to WSC, and on to Marshall Space Flight Center.

MEIT activities are beginning the "Race to Space" and the GSFC ISS Test Team and Network elements are in place to support this major ISS integration activity.

By John Smith/LMSC/GSFC Code 451

For further information, check out the Human Spaceflight Web site at http://shuttle.nasa.gov or contact Ted Sobchak at (301) 286-7813 or via email at Ted.Sobchak@gsfc.nasa.gov

Progress on TDRSS Demand Access Unveiled

The desirability of providing more timely Space Network (SN) service, of extending SN service to smaller missions, and of providing SN service at a reduced cost have given impetus to a new Networks and Mission Services Projects (N&MSP) initiative. Planning is currently underway to streamline operational access to spacecraft and other TDRSS customer platforms. This provision for automated TDRSS service-on-demand is called Demand Access. At present, there are two complementary Demand Access (DA) initiatives under way.

The first, DA Service, is a proof-of-concept program. N&MSP engineers are prototyping and testing equipment that will provide an Internet Protocol interface to the SN with no changes to SN facilities. A web page is being developed that will soon give customers low-priority access to the SN resources during unscheduled open time.

The second DA initiative, the DA System (DAS), will greatly expand the Multiple Access return link service capacity by providing additional equipment to SN facilities. Inexpensive new beamforming and demodulating equipment will be added to the Space to Ground Link, as well as a processing capability and a customer planning interface. Eventually, customers may be able to automatically generate schedules, and even obtain continuous return service (for customers with dedicated beamformers and demodulators). Unplanned return services initiated by customer platforms may be made possible with the addition of a polling capability that scans for unscheduled transmissions. The system would allow for immediate detection of an anomaly or emergency, as well as collection of opportunistic observations of unpredictable astronomical events or other phenomena.

Information on this project is available on the web site *http://nmsp.gsfc.nasa.gov/* under "TDRS Info." The site discusses the plans for a phased approach to implementing the DAS. Updates will be posted frequently to document DAS progress.

By Frances Ferguson/STel

For more information, visit the web site referenced above, or contact Andre Fortin/GSFC Code 451 at (301) 286-7829 or via email at Andre.Fortin@gsfc.nasa.gov

Landsat-7 Spacecraft Undergoing Final Launch Preparation

Landsat-7 was flown to Vandenberg Air Force Base on January 28, 1999. It is in the Integrated Processing Facility (IPF) at Spacecraft Launch Complex 6 (SLC-6) where it will undergo final performance testing, configuration for flight, and hydrazine fueling. Prior to launch, it will spend the final two weeks atop the Delta II Expendable Launch Vehicle at the launch pad, SLC-2W. Activities at the pad will be minimized (health tests, final thermal blanket closeout, green tag/red tag installation and removal, and final inspection). The launch date is under review due to a very crowded launch manifest, but should be scheduled for the late March to mid-April time frame.

Since the last report, the following Landsat-7 observatory level activities have been completed: thermal vacuum

and thermal balance testing, acoustic testing, solar array pyro deployment tests, flight battery installation, system end-to-end testing, mass property and alignment checks, leak testing, and a final preship Comprehensive Performance Test.

The Landsat Mission Operations Center (MOC) is launch-ready. The Flight Operations Team (FOT) and the Flight Support Team (FST) are preparing for launch by participating in a series of "launch and on-orbit activation" simulations. An observatory simulator capable of receiving commands and providing telemetered responses to actions taken by the controllers in the MOC is the primary training tool. When a failure is simulated, the FOT and FST go through a contingency recovery process that has been generated by subsystem experts. These steps ensure the contingency procedures are adequate and also train the team in using the process.

The Landsat Data Handling Facility (DHF) [which consists of the Landsat Ground Station (LGS), Landsat Processing System (LPS), and Image Assessment System (IAS)] developed by GSFC is in place at the United States Geological Survey's (USGS) Earth Resources Observing System (EROS) Data Center (EDC) at Sioux Falls, SD. It is undergoing final tests in preparation for launch. The DHF has played a key role in verifying Enhanced Thematic Mapper Plus (ETM+) instrument performance by processing instrument data taken during instrument and observatory performance testing. After processing by the DHF, the data are provided to the Landsat Science Office for verification that specified instrument performance requirements are met.

A major change in the Landsat-7 program structure has taken place. GSFC is now responsible for the design, development, launch, and on-orbit checkout of the satellite; design, development, and installation of the ground system; providing a fully trained FOT; and operating the satellite until October 2000. The U.S. Geological Survey (USGS) is responsible for capture, processing, and distribution of the data; mission management; maintaining an archive of Landsat and other remotely sensed data; and in October 2000, will take over satellite operations. The National Oceanic and Atmospheric Administration (NOAA) is no longer directly involved in the program but will continue to be a Landsat data customer.

Future dates of note:

- Landsat-7 launch – late March to mid April
- Completion of on-orbit checkout, beginning of normal operations – approximately launch + 60 days
- One day workshop "Opportunities for Value-added Processors in the Landsat-7 Era: Commercial, Non-Profit, and Educational," at USGS Headquarters in Reston, VA (sponsored by the USGS and NASA, in cooperation with the American Society of Photogrammetry and Remote Sensing), March 4
- Landsat Science Team meeting in Solvang, CA (dates TBD pending launch date)
- Landsat Technical User's Working Group meeting at the EROS Data Center in Sioux Falls, SD, June 28 – July 2, 1999.

By Ken Dolan/GSFC Code 430

For more information, please see the Landsat-7 home page at http://geo.arc.nasa.gov/sge/landsat/landsat.html or contact the author at (301) 286-7962 or via email at Stephen.K.Dolan.1@gsfc.nasa.gov

Landsat-7 Ground Station Prepares for Operations

The Landsat-7 Ground Station, (LGS) located at the Earth Resources Observing System (EROS) Data Center (EDC) in Sioux Falls, SD, is being integrated by GSFC for the U.S. Geological Survey (USGS). The ground station is now in the final checkout phase. AlliedSignal Technical Services (ATSC), Raytheon Systems Company (RSC), EDC, and GSFC personnel are currently closing out open LGS work-off list items.

Testing is under way with the Flight Dynamics Facility (FDF) to certify the LGS Doppler tracking accuracy. During the tracking tests, certified tracking stations and the LGS will track the Cosmic Background Explorer Satellite (COBE). The LGS has supported system testing by playing back data tapes to the Landsat-7 Processing System (LPS). In addition, LGS and Landsat-7 Project personnel are coordinating tape transfer tests from the Alaska and Spitzbergen polar ground stations. New LGS operators are in training, and the LGS is currently operating with two shifts to accommodate the increased workload.

In late 1998, three Scientific Atlanta X-Band bit-synchronizers were returned to the factory for warranty

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repair. Given tight schedule constraints, RSC worked with the vendor to accelerate equipment repair. The X-Band equipment is now fully integrated and has successfully passed Site Acceptance Testing (SAT). The antenna system, which was damaged from a severe hailstorm in 1997, was found to have suffered rodent damage to the underground power cable. A new power cable is being installed and rodent proof putty is being used to seal all entrance locations.

The Landsat-7 launch is currently scheduled for late March to mid April 1999.

By Armen Caroglanian/GSFC Code 567

More information on the Landsat-7 project, including the launch date, can be found on the Internet at: http://geo.arc.nasa.gov/sge/landsat/landsat.html or contact the author by telephone at (301) 286-4340, or via email armen.caroglanian@gsfc.nasa.gov

The LGS 10 Meter Antenna

TDRS H,I,J White Sands Complex Modifications Near Completion

Although the TDRS H,I,J spacecraft were specified to have capabilities similar to the existing fleet of six on-orbit TDRSs, there are some significant additions and differences. In addition to the well-known features of the original TDRS fleet, TDRS H,I,J feature a new Ka-Band Single Access service and enhanced Multiple Access (MA) service provided via on-board (vs. ground-based) beamforming. The command, telemetry, and autotrack systems on TDRS H,I,J are not implemented identically to TDRS-1 through -7, resulting in different interface requirements with the White Sands Complex (WSC). The WSC therefore requires modifications to accommodate the new generation of TDRS.

Following the contractor System Critical Design Review held in June 1997, the TDRS H,I,J Ground Segment Contractor [Raytheon Systems Corporation (RSC), located in Denver, Colorado] effected development of WSC Ground Segment changes. In late 1997, system demonstrations of the TDRS H,I,J KSA autotrack and Ka-Band service performance were successfully conducted at WSC, utilizing TDRS H,I,J prototype hardware, new and modified WSC hardware for TDRS H,I,J, as well as heritage unmodified WSC equipment. In addition, WSC provided support to an MA channel demonstration activity at the RSC factory in El Segundo, CA.

A key breakthrough in this effort was made when a no-cost change was negotiated with the TDRS H,I,J contractor to merge the TDRS H,I,J development baseline with the evolving WSC operational baseline prior to system/subsystem integration and test activities. This change results in a single WSC baseline established for Space Network operations as part of the TDRS H,I,J contract, avoids the existence of multiple different baselines for TDRS H,I,J and Space Network operations, and mitigates the need for a future merge by the Operations and Maintenance contractor.

The TDRS H,I,J modifications to WSC started with Space to Ground Link Terminal-1 (SGLT-1) at the White Sands Ground Terminal (WSGT, a.k.a. Cacique) and the Software Maintenance and Training Facility in early 1998. Modifications continued with SGLTs 2, 4, 5 and the S-Band TTC systems at the Second TDRSS Ground Terminal (STGT, a.k.a Danzante) and WSGT.

All WSC modifications for TDRS H,I,J are now virtually complete, including all testing at the WSGT. Testing of the

modifications at the STGT is ongoing, with completion expected in April 1999. One of the major goals of the WSC TDRS H,I,J Integration and Test Program has been to minimize any impacts to Space Network Operations. This goal has been successfully accomplished with advance planning and customer cooperation, even though numerous TDRS hand-overs have been required.

In addition to the enhancements to the WSC technical systems for TDRS H,I,J, many other activities are occurring in preparation for the upcoming TDRS-H launch. These activities include training of WSC Operations and Maintenance personnel; incorporation of TDRS H,I,J changes into existing WSC Local Operations Procedures; finalization of hardware, software, and firmware maintenance documentation; and completion of a TDRS H,I,J spare parts procurement.

The launch of TDRS-H is planned for the summer of 1999. After a successful launch, a period of spacecraft bus and payload on-orbit testing is planned prior to the transition of TDRS-H into Space Network operations.

By Bryan Gioannini/Deputy Station Director

For further information, please contact the author at (505) 527-7000.

Earth Science Data and Information System Update

All component systems of the Earth Science Data and Information System (ESDIS) achieved significant progress over the last four months and are on track for the July 15, 1999 launch date of EOS AM-1. [This launch date was designated in October 1998, after approval of the EOS Data and Information System (EOSDIS) Core System (ECS) Mission Operations System (EMOS) reformulation strategy for the ECS Flight Operations Segment.]

Team members working on the science segment of the ECS, the Science Data System, continue to successfully test releases leading to launch readiness. For this science system, limited data support for Landsat-7 is also required, and successful end-to-end testing indicates readiness for the late March to mid-April 1999 launch of Landsat-7. Planned software upgrades will continue to implement performance enhancement for support of AM-1.

Build 1.1 of EMOS was used to support a successful interface test with the AM-1 and instruments on January 28, 1999. All test objectives were met. Slight problems observed with EMOS Build 1.1, such as slow command load uplink time (being worked), clock correlation software errors (fixed), and project database file corruption (due to procedural error) are being resolved in a timely manner.

The Flight Operations Team (FOT) continues to run Operational Readiness Test (ORT) exercises which simulate both the AM-1 launch scenario as well as normal operations for AM-1. The FOT is also running "Day in the Life" simulations that exercise all areas of the EMOS mission management subsystem.

Look in the next issue of *The Integrator* for more information on this rapidly changing program.

By Gene Smith/Code 423/581

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New QuikSCAT Launch Date Established

A new tentative launch date of April 27, 1999 has been established for NASA's Quick Scatterometer (QuikSCAT) mission. Originally scheduled for November 24, 1998, QuikSCAT's launch was delayed due to problems with the Titan launch vehicle. All Titan missions were canceled for a period of time following a Titan IV accident in August 1998 in which a U.S. government satellite was destroyed. QuikSCAT's orbit will be sun-synchronous, at an 803 kilometer altitude, with an inclination of 98.6 degrees. Mission life expectancy is two years.

The QuikSCAT mission was conceived after the Japanese Advanced Earth Observing Satellite (ADEOS) suffered a fatal failure in June 1997 after less than a year on orbit. The Scatterometer instrument on ADEOS collected global sea surface and wind measurements that were used for scientific climate research, including weather prediction, El Niño studies, and estimations of tropical rain forest reduction. QuikSCAT, a joint mission between the Jet Propulsion Laboratory (JPL) and GSFC, was designed to continue the

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The QuikSCAT Spacecraft

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scatterometer scientific mission begun by ADEOS. JPL is responsible for QuikSCAT project management and furnishing the scatterometer instrument and science ground processing systems. GSFC is responsible for managing the spacecraft contract with Ball Aerospace & Technologies Corporation, providing the NASA ground system, and obtaining the Titan II launch vehicle from the Air Force.

QuikSCAT was procured in record time by utilizing the services of GSFC's Rapid Spacecraft Development Office (RSDO). Under an RSDO program called Rapid I, QuikSCAT customers (JPL and GSFC) staged a minicompetition between vendors who had already established Indefinite Delivery Indefinite Quantity (IDIQ) contracts with the government. The delivery order for QuikSCAT was placed with the winning contractor (Ball Aerospace & Technologies Corporation) only 16 days after the Request for Offer (RFO) was released. Eleven months later, the satellite was complete and ready for shipment to the launch base (Vandenberg Air Force Base).

The QuikSCAT spacecraft remains equipped and fit for launch. Testing of the EOS Polar Ground Network (EPGN) which will support QuikSCAT is currently under way. All QuikSCAT software has been successfully tested to ensure no issues with the approaching Year 2000 exist.

For additional information, please visit the Internet site at the following URL: http://winds.jpl.nasa.gov/missions/quikscat/quikindex.html or contact Raymond Pages/GSFC Code 581.2 at (301) 286-6012.

Earth Observing System Polar Ground Stations Project

Earth Observing System (EOS) Polar Ground Stations (EPGS) Project personnel continue to prepare for mission support starting with the Landsat-7 launch, now scheduled for late March to mid April 1999 and the QuikSCAT launch, now scheduled for April 27, 1999. In November 1998, the EPGS project took advantage of these revised launch dates by initiating a project replan of key activities. Replanned activities included stabilization of the Programmable Telemetry Processor (PTP) operations through software and hardware improvements, upgrading the automation software to increase its capabilities, and moving operations at Svalbard Ground Station (SGS) from a trailer to a permanent building.

New Building in Svalbard Ground Station (Norway)

The new building at SGS was constructed by the Norwegian Space Center (NSC) to alleviate the space limitations and environmental issues associated with operating from a temporary trailer. A detailed move plan was developed and closely coordinated with flight project ground system managers to ensure appropriate recertification tests and project testing was accommodated and completed prior to the Landsat-7 launch. It should be noted that the equipment was moved, installed, tested, and ready to support the flight projects in two weeks – less than half the originally estimated time – thanks to the tremendous efforts by the NSC and Wallops Flight Facility personnel. The new building offers excellent conditions for both the work to be done and personal comfort.

Two major software upgrades and associated tests have also occurred, significantly improving overall system stability. Automation software Version 2.0 and the upgraded PTP software (Version 1.4) are now in place and will be frozen for the Landsat-7 launch. This version of the automation software nearly completes the software development effort, and all upcoming spacecraft support will be performed using a combination of automated and manual operations.

In addition to the equipment move and station upgrades, the operations and technical teams have been supporting spacecraft emergencies, and preparing for and supporting sounding rocket campaigns.

Other EPGS activities for the Landsat-7 and QuikSCAT launches include participation in a series of readiness reviews and mission readiness tests. These reviews include the Landsat-7 ground system Operational Readiness Review (ORR) and the QuikSCAT ground ORR. The EPGS project will also conduct its own ORR on March 3, 1999 to assess the readiness of the EPGS across all project disciplines for Landsat-7 and QuikSCAT support.

EPGS Equipment in New Svalbard Ground Station Building

EPGS project planning is also continuing for a phase II implementation. The phase II implementation will provide increased tracking and data acquisition capabilities necessary for the additional EOS missions starting with PM-1 (December 2000 launch). NASA is currently evaluating two options for the phase II implementation, the first of which involves proceeding with plans to procure and implement a second antenna at SGS. The second option involves NASA procuring commercial ground station services via the Consolidated Space Operations Contract (CSOC). A decision on the phase II options is expected by mid April 1999.

Key EPGS Project Milestones

- Landsat-7 Ground System ORR: 2/23/99
- EPGS ORR: 3/3/99
- QuikSCAT Ground System ORR: 3/4/99
- Landsat-7 Launch Planning Date: late March to mid-April
- QuikSCAT Launch Planning Date: 4/27/99

By Mark Burns/STel

For more information regarding EPGS, please contact Bob Stelmaszek at (301) 286-5263.

Updated Networks and Mission Services Projects Charts Provided

We have updated both the **Ground Network Project Milestones** chart and the **Networks and Mission Services Projects Schedule** and included them in the center of this issue of *The Integrator*.

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